**AK4499** 



## = Preliminary =

# Premium Switched Resistor 4ch DAC

#### 1. General Description

The AK4499 is a 32-bit 4ch Switched Resistor DAC which adopts newly developed technology, achieving the industry's leading level low distortion and low noise characteristics. It corresponds to a 768kHz PCM input and an DSD512 input at maximum, suitable for playback of high resolution audio sources that are becoming widespread in Network Audio and USB-DACs Audio systems. In addition, it is capable of supporting a wide range of signals and achieving low out-of-band noise. The AK4499 has six types of 32-bit digital filters, realizing simple and flexible sound reproduction in wide range of applications.

#### 2. Features

- 4-ch Switched Resistor DAC
- THD+N: -124 dB
- Dynamic Range, S/N: 140 dB (Mono), 137 dB (Stereo), 134 dB (4ch)
- 128x Over Sampling
- Sampling Rate: 8 kHz ~ 768 kHz
- 32-bit 8x Digital Filter Short Delay Sharp Roll-off, GD = 6.0/fs Short Delay Slow Roll-off, GD = 5.0/fs Sharp Roll-off Slow Roll-off Super Slow Roll-off Low Dispersion Short Delay Filter
- DSD64, DSD128, DSD256, DSD512 Input Support Filter1 (fc = 37 kHz, DSD64 mode)
   Filter2 (fc = 65 kHz, DSD64 mode)
- Digital De-emphasis for 32, 44.1 and 48kHz sampling
- Soft Mute
- Digital Attenuator (0 dB ~ -127 dB, 0.5 dB step + mute)
- Mono Mode
- External Digital Filter Interface (EXDF Mode)
- PCM/DSD, EXDF/DSD Mode Automatic Mode Switching Function
- Audio I/F Format
  - MSB Justified
  - LSB Justified
- I<sup>2</sup>S
- DSD
- TDM
- Daisy Chain
- Master Clock
- fs = 8 kHz ~ 32 kHz: 256fs, 384fs, 512fs, 768fs, 1152fs
- fs = 32 kHz ~ 54 kHz: 256fs, 384fs, 512fs, 768fs
- fs = 54 kHz ~ 108 kHz: 256fs, 384fs
- fs = 108 kHz ~ 216 kHz: 128fs, 192fs
- fs = 384 kHz : 32fs, 48fs, 64fs, 96fs
- fs = 768 kHz : 16fs, 32fs, 48fs, 64fs
- Register Control Mode with 3-wire Serial or I<sup>2</sup>C interface

- Pin Control Mode
- Power Supply: Internal LDO (LDOE pin = "H"); TVDD = 3.0 ~ 3.6 V, AVDD = 4.75 ~ 5.25 V, VDDL1/R1/L2/R2 = 4.75 ~ 5.25 V
   External Supply (LDOE pin = "L"); TVDD = 1.7 ~ 3.6 V, DVDD = 1.7 ~ 1.98 V,
- AVDD = 4.75 ~ 5.25 V, VDDL1/R1/L2/R2 = 4.75 ~ 5.25 V
- Operational Temperature: -40 ~ 85 °C
- Digital Input Level: CMOS
- Package: 128-pin HTQFP



#### 3. Block Diagram and Functions

#### 3.1. Block Diagram

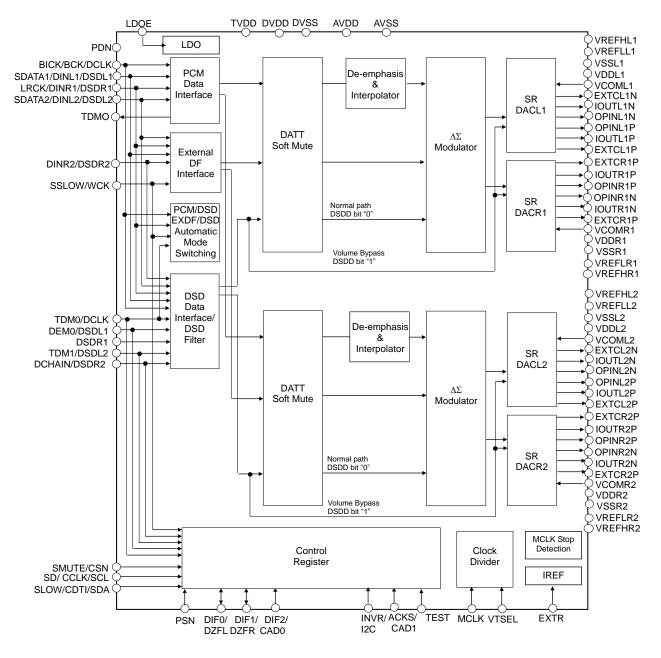
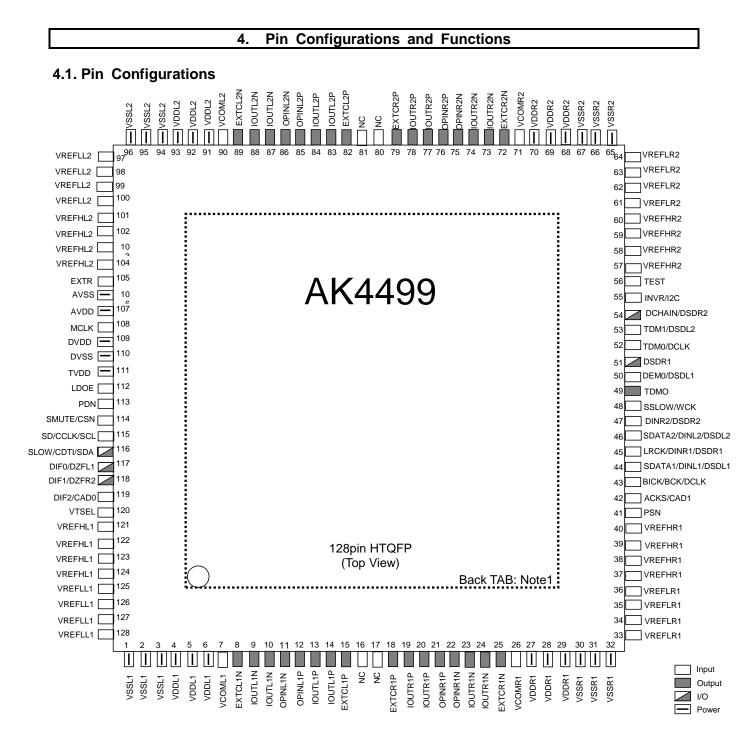


Figure 1. AK4499 Block Diagram

#### 3.2. Functions

Block	Function
PCM Data Interface	Execute serial/parallel conversion of SDATA1/2 input data by synchronizing with LRCK and BICK, and generate TDM output data.
External DF Interface	Receive external digital filter outputs. Execute serial/parallel conversion of DINL1/2 and DINR1/2 input data by synchronizing with BICK.
DSD Data Interface	1-bit data that is input from DSDL1/2 and DSDR1/2 pins is received by synchronizing with DCLK.
DSD Filter	FIR filter that reduces high frequency noise of DSD input data
DATT, Soft Mute	Apply DATT and Soft Mute process to input data.
De-emphasis &	A digital filter that applies De-emphasis process to input data and executes
Interpolator	over sampling.
ΔΣ Modulator	Output multi-bit data to SR DAC. This block consists of a third-order digital delta-sigma modulator.
SR DAC	Convert multi bit output of $\Delta\Sigma$ Modulator into analog signal. This block consists of a switched resistor DAC.
Control Register	Keep register settings for each mode. Control registers are accessed in 3-wire (CSN, CCLK, CDTI) or I2C-Bus (SCL, SDA) control mode.
Clock Divider	Divide Master Clock In PCM mode, master clock is divided automatically by fs rate auto detection function. In DSD mode, the master clock frequency is set by DCKS bit.
MCLK Stop Detection	Detects when the master clock input is absent.
IREF	Generate reference current from the reference voltage generated internally, using an external resistor.
LDO	Generate power for internal digital circuit (1.8V typ.).



Note 1: The exposed pad on the bottom surface of the package must be connected to ground (AVSS).

#### 4.2. Functions

No.	Pin Name	I/O	Function	Power Down State
1-3	VSSL1	-	L1ch Analog Ground pin.	-
4-6	VDDL1	-	L1ch Analog Power Supply pin.	_
7	VCOML1	1	L1ch VCOM pin. VCOML1 is connected to the midpoint of resistors between VREFHL1 and VREFL1.	Hi-Z
8	EXTCL1N	0	External Capacitor connection pin. This pin should be connected to 1 $\mu$ F to VSSL1.	Pull-down to VSSL1 (250 kΩ, typ)
9,10	IOUTL1N	0	Current Output pin (L1ch Negative Signal).	Connected to OPINL1N (64 Ω, typ)
11	OPINL1N	0	Common Voltage Input pin (L1ch Negative Signal).	Connected to IOUTL1N (64 Ω, typ)
12	OPINL1P	0	Common Voltage Input pin (L1ch Positive Signal).	Connected to IOUTL1P (64 Ω, typ)
13,14	IOUTL1P	0	Current Output pin (L1ch Positive Signal).	Connected to OPINL1P (64 Ω, typ)
15	EXTCL1P	0	External Capacitor connection pin. This pin should be connected to 1 $\mu$ F to VSSL1.	Pull-down to VSSL1 (250 kΩ, typ)
16,17	NC	-	No internal bonding. Connect to AVSS.	-
18	EXTCR1P	0	External Capacitor connection pin. This pin should be connected to 1 $\mu$ F to VSSR1.	Pull-down to VSSR1 (250 kΩ, typ)
19,20	IOUTR1P	0	Current Output pin (R1ch positive signal).	Connected to OPINR1P (64 Ω, typ)
21	OPINR1P	0	Common Voltage input pin (R1ch positive signal).	Connected to IOUTR1P (64 Ω, typ)
22	OPINR1N	ο	Common Voltage input pin (R1ch negative signal).	Connected to IOUTR1N (64 Ω, typ)
23,24	IOUTR1N	0	Current Output pin (R1ch negative signal).	Connected to OPINR1N (64 Ω, typ)
25	EXTCR1N	0	External Capacitor connection pin. This pin should be connected to 1 $\mu$ F to VSSR1.	Pull-down to VSSR1 (250 kΩ, typ)
26	VCOMR1	1	R1ch VCOM pin. VCOMR1 is connected to the midpoint of resistors between VREFHR1 and VREFLR1.	Hi-Z
27-29	VDDR1	-	R1ch Analog Power Supply pin.	-
30-32	VSSR1	-	R1ch Analog Ground pin.	-
33-36	VREFLR1		R1ch Low Level Reference Voltage Input pin.	Hi-Z
<u>37-40</u> 41	VREFHR1 PSN		R1ch High Level Reference Voltage Input pin. Control Mode Select pin (Internal pull-up pin) "L": Register Control mode "H": Pin Control mode	Hi-Z Pull-Up to TVDD (100 kΩ, typ)

$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	No.	Pin Name	I/O	Function	Power Down State
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	42	ACKS	I	"L": Fixed Speed mode "H": Auto Setting mode	Hi-Z
43       BCK       I       Audio Serial Data Clock pin in EXDF mode       Hi-Z         0CLK       I       DSD Clock Pin in DSD mode (@DSDPATH bit = "1")       Hi-Z         44       DINL1       I       Audio Serial Data Input pin in PCM mode       Hi-Z         44       DSDL1       I       Audio Serial Data Input pin in DSD mode       Hi-Z         45       DSDL1       I       Audio Serial Data Input pin in DSD mode       Hi-Z         45       DINR1       I       Audio Serial Data Input pin in DSD mode       Hi-Z         46       DINR1       I       Audio Serial Data Input pin in EXDF mode       Hi-Z         47       DSDR1       I       Audio Serial Data Input pin in EXDF mode       Hi-Z         48       DINR2       I       Audio Serial Data Input pin in EXDF mode       Hi-Z         47       DSDR2       I       Audio Serial Data Input pin in EXDF mode       Hi-Z         48       SSLOW       I       Digital Filter Select pin in Pin Control mode       Hi-Z         49       TDMO       O       Audio Serial Data Input pin in DSD mode       Hi-Z         50       DSDL1       I       Audio Serial Data Input pin in DSD mode		CAD1		Chip Address 1 pin in Register Control mode	
DCLK       I       DSD Clock Pin in DSD mode (@DSDPATH bit = "1")         44       DINL1       I       Audio Serial Data Input pin in PCM mode       Hi-Z         44       DINL1       I       Audio Serial Data Input pin in DSD mode       Hi-Z         45       DSDL1       I       (@DSDPATH bit = "1")       Hi-Z         45       DSR1       I       Audio Serial Data Input pin in PCM mode       Hi-Z         46       DINR1       I       Audio Serial Data Input pin in DSD mode       Hi-Z         47       DSDL2       I       Audio Serial Data Input pin in DSD mode       Hi-Z         47       DSDR2       I       Audio Serial Data Input pin in DSD mode       Hi-Z         48       SLOW       I       Digta Filter Select pin in Pin Control mode       Hi-Z         47       DSDR2       I       Audio Serial Data Input pin in DSD mode       Hi-Z         48       SLOW       I       Digtal Filter Select pin in Pin Control mode       Hi-Z         49       TDMO       Q       Audio Serial Data Input pin in DSD mode       Hi-Z         50       DSDL1       I       Audio Serial Data Input pin in DSD mode       Hi-Z		BICK		Audio Serial Data Clock pin in PCM mode	
SDATA1       I       Audio Serial Data Input pin in PCM mode         44       DINL1       I       Audio Serial Data Input pin in EXDF mode       Hi-Z         DSDL1       I       Audio Serial Data Input pin in DSD mode       Hi-Z         45       DINR1       I       Audio Serial Data Input pin in EXDF mode       Hi-Z         46       DSDR1       I       Audio Serial Data Input pin in DSD mode       Hi-Z         46       DSDL2       I       Audio Serial Data Input pin in DSD mode       Hi-Z         47       SDATA2       I       Audio Serial Data Input pin in DSD mode       Hi-Z         48       DINR2       I       Audio Serial Data Input pin in DSD mode       Hi-Z         47       DSDR2       I       Audio Serial Data Input pin in DSD mode       Hi-Z         48       SSLOW       I       Digital Filter Select pin in Pin Control mode       Hi-Z         49       TDMO       O       Audio Serial Data Input pin in DSD mode       Hi-Z         50       DSDL1       I       Deemphasis Enable pin in Pin Control mode       Hi-Z         51       DSDR1       I       Deemphasis Enable pin in DSD mode       Hi-Z <td< td=""><td>43</td><td>BCK</td><td>I</td><td>Audio Serial Data Clock pin in EXDF mode</td><td>Hi-Z</td></td<>	43	BCK	I	Audio Serial Data Clock pin in EXDF mode	Hi-Z
44   DINL1   I   Audio Serial Data Input pin in EXDF mode   Hi-Z     35   DSDL1   I   Audio Serial Data Input pin in DSD mode   Hi-Z     45   LRCK   I   Input Channel Clock pin in PCM mode   Hi-Z     46   DINR1   I   Audio Serial Data Input pin in EXDF mode   Hi-Z     66   DSDR1   I   Audio Serial Data Input pin in DSD mode   Hi-Z     67   DSDR12   I   Audio Serial Data Input pin in DSD mode   Hi-Z     68   DINL2   I   Audio Serial Data Input pin in DSD mode   Hi-Z     70   DSDR2   I   Audio Serial Data Input pin in DSD mode   Hi-Z     47   DSDR2   I   Audio Serial Data Input pin in DSD mode   Hi-Z     48   SSLOW   I   Digital Filter Select pin in Din Control mode   Hi-Z     49   TDMO   O   Audio Serial Data Input pin in DSD mode   HI-Z     50   DSDL1   I   De-emphasis Enable pin in Pin Control mode   HI-Z     51   DSDR1   I   Audio Serial Data Input pin in DSD mode   HI-Z     52   TDMO   O   Audio Serial Data Input pin in DSD mode   HI-Z     53   DSDL1   I   De-emphasis Enable pin in Pin control mode   HI-Z </td <td></td> <td>DCLK</td> <td>I</td> <td>DSD Clock Pin in DSD mode (@DSDPATH bit = "1")</td> <td></td>		DCLK	I	DSD Clock Pin in DSD mode (@DSDPATH bit = "1")	
44       DSDL1       I       Audio Serial Data Input pin in DSD mode       Hi-Z         45       DINR1       I       Input Channel Clock pin in PCM mode       Hi-Z         46       DINR1       I       Audio Serial Data Input pin in DSD mode       Hi-Z         46       SDATA2       I       Audio Serial Data Input pin in DSD mode       Hi-Z         46       DINL2       I       Audio Serial Data Input pin in DSD mode       Hi-Z         47       DSDL2       I       Audio Serial Data Input pin in DSD mode       Hi-Z         48       DINR2       I       Audio Serial Data Input pin in DSD mode       Hi-Z         47       DSDR2       I       Audio Serial Data Input pin in DSD mode       Hi-Z         48       SSLOW       I       Digital Filter Select pin in Pin Control mode       Hi-Z         49       TDMO       O       Audio Serial Data Input pin in DSD mode       Hi-Z         50       DSDL1       I       Decemphasis Enable pin in Pin Control mode       DVSS         51       DSDR1       I       Decemphasis Enable pin in DSD mode       Hi-Z         60       DSDL1       I       Audio Serial Data Input pin in DSD mode<		SDATA1		Audio Serial Data Input pin in PCM mode	
DSDL1       I       Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "1")         45       LRCK       I       Input Channel Clock pin in PCM mode DSDR1       I         45       DINR1       I       Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "1")       Hi-Z         46       DINL2       I       Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "1")       Hi-Z         47       SDAT2       I       Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "1")       Hi-Z         48       SSLOW       I       Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "1")       Hi-Z         48       SSLOW       I       Digital Filter Select pin in DSD mode (Internal pull-down pin in EXDF mode       Hi-Z         49       TDMO       O       Audio Serial Data Input pin in DSD mode (Internal pull-down pin)       Pull-down to DVSS (100 kQ, typ)         50       DEM0       I       De-emphasis Enable pin in Pin Control mode (Internal pull-down pin)       Hi-Z         51       DSDL1       I       Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")       Hi-Z         52       TDMO       I       De-emphasis Enable pin in Pin control mode. DCLK       Hi-Z       Hi-Z         53       DSDL1	4.4	DINL1	I	Audio Serial Data Input pin in EXDF mode	11: 7
45       DINR1       I       Audio Serial Data Input pin in EXDF mode (@DSDPATH bit = "1")       Hi-Z         46       DSDL2       I       Audio Serial Data Input pin in PCM mode DINL2       Hi-Z       Hi-Z         46       DSDL2       I       Audio Serial Data Input pin in PCM mode DINL2       Hi-Z       Hi-Z         47       DSDR2       I       Audio Serial Data Input pin in EXDF mode (@DSDPATH bit = "1")       Hi-Z         48       SSLOW       I       Digital Filter Select pin in Pin Control mode (Internal pull-down pin)       Hi-Z         49       TDMO       O       Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "1")       Pull-down to DVSS (100 kΩ, typ)         50       DEM0       I       Degraphase Enable pin in Pin Control mode (Internal pull-down pin)       Pull-down to DVSS (100 kΩ, typ)         51       DSD11       I       Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")       Hi-Z         52       TDM0       I       De-emphasis Enable pin in Pin control mode.       Hi-Z         53       DSDL2       I       Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")       Hi-Z         54       DSDL2       I       Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")       Hi-Z </td <td>44</td> <td>DSDL1</td> <td>I</td> <td></td> <td>ΠI-Z</td>	44	DSDL1	I		ΠI-Z
45   DSDR1   I   Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "1")   HI-2     46   DINL2   I   Audio Serial Data Input pin in PCM mode DINL2   Hi-2     46   DSDL2   I   Audio Serial Data Input pin in EXDF mode (@DSDPATH bit = "1")   Hi-Z     47   DINR2   I   Audio Serial Data Input pin in EXDF mode (@DSDPATH bit = "1")   Hi-Z     48   SSLOW   I   Digital Filter Select pin in Pin Control mode (@DSDPATH bit = "1")   Hi-Z     48   SSLOW   I   Digital Filter Select pin in Pin Control mode (Internal pull-down pin)   Hi-Z     50   DEM0   I   De-emphasis Enable pin in Pin Control mode (@DSDPATH bit = "0")   Hi-Z     51   DSDR1   I   Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")   Hi-Z     52   TDM0   I   De-emphasis Enable pin in Pin Control mode (@DSDPATH bit = "0")   Hi-Z     52   TDM0   I   DSDR1 bit = "0")   Hi-Z     53   DSDL2   I   Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")   Hi-Z     54   DSDR2   I   Audio Serial Data Input pin in Pin control mode.   Hi-Z     54   DSDR2   I   Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")   Hi-Z     55   I2C   I <td></td> <td>LRCK</td> <td></td> <td>Input Channel Clock pin in PCM mode</td> <td></td>		LRCK		Input Channel Clock pin in PCM mode	
DSDR1IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "1")46DINL2IAudio Serial Data Input pin in PCM mode DSDL2I47DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "1")Hi-Z47DINR2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "1")Hi-Z48SSLOWIDigital Filter Select pin in Pin Control mode (Internal pull-down pin)Hi-Z48SSLOWIDigital Filter Select pin in Pin Control mode (Internal pull-down pin)Hi-Z49TDMOOAudio Serial Data Input pin in DSD mode (Internal pull-down pin)Pull-down to DVSS (100 kQ, typ)50DEM0IDe-emphasis Enable pin in Pin Control mode (Internal pull-down pin)Hi-Z51DSD11IDe-emphasis Enable pin in DSD mode (@DSDPATH bit = "0")Hi-Z52TDM0IDe-emphasia Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z53DSL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z54DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z55I2CIAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS	45	DINR1	I	Audio Serial Data Input pin in EXDF mode	11: 7
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	45	DSDR1	I		ΠI-Z
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		SDATA2			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	46	DINL2	I	Audio Serial Data Input pin in EXDF mode	Ц; 7
47DSDR2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "1")Hi-Z48SSLOWIDigital Filter Select pin in Pin Control modeHi-Z49TDMOOAudio Serial Data Output pin in EXDF modePull-down to DVSS (100 kΩ, typ)49TDMOOAudio Serial Data Output pin in Daisy Chain mode (Internal pull-down pin)Pull-down to DVSS (100 kΩ, typ)50DEM0IDe-emphasis Enable pin in Pin Control modeHi-Z51DSDL1IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z51DSDR1IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z52TDM0ITDM Mode select 0 pin in Pin control mode. DCLKHi-Z53DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z54DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z55I2CIAudio Serial Data Input Pin in DSD mode (@DSDPATH bit = "0")Hi-Z55I2CISerial Control Interface Select pin in Pin Control mode. (@DSDPATH bit = "0")Hi-Z56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS	40	DSDL2	I		ni-2
DSDR21(@DSDPATH bit = "1")48SSLOWIDigital Filter Select pin in Pin Control modeHi-Z49TDMOOAudio Serial Data Output pin in EXDF modePull-down to DVSS (100 kΩ, typ)49TDMOOAudio Serial Data Output pin in Daisy Chain mode (Internal pull-down pin)Pull-down to DVSS (100 kΩ, typ)50DEM0IDe-emphasis Enable pin in Pin Control mode (@DSDPATH bit = "0")Hi-Z51DSDL1IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z52TDM0ITDM Mode select 0 pin in Pin control mode. (@DSDPATH bit = "0")Hi-Z53DSL2ITDM Mode select 1 pin in Pin control mode. (@DSDPATH bit = "0")Hi-Z54DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z54DSDR2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z55I2CIAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z55I2CIR1/2ch Signal Invert pin in DSD mode (@DSDPATH bit = "0")Hi-Z56TESTIConnect to DVSS (Internal control interface. "H": I²C Bus serial control interface. "H": I²C Bus serial control interface.Pull-down to DVSS		DINR2		Audio Serial Data Input pin in EXDF mode	
48SSLOWIDigital Filter Select pin in Pin Control modeHi-Z49TDMOOAudio Serial Data Output pin in Daisy Chain mode (Internal pull-down pin)Pull-down to DVSS (100 kΩ, typ)50DEM0IDe-emphasis Enable pin in Pin Control mode (@DSDPATH bit = "0")Hi-Z51DSDR1IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z51DSDR1IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z52TDM0ITDM Mode select 0 pin in Pin control mode. (@DSDPATH bit = "0")Hi-Z53TDM1IDSD Clock pin in DSD mode (@DSDPATH bit ="0")Hi-Z54DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z54DSDR2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z55I2CIDaisy Chain Mode Select pin in DSD mode (@DSDPATH bit = "0")Hi-Z55I2CIR1/2ch Signal Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS	47	DSDR2	I		Hi-Z
WCKIWord Clock input pin in EXDF mode49TDMOOAudio Serial Data Output pin in Daisy Chain mode (Internal pull-down pin)Pull-down to DVSS (100 kΩ, typ)50DEM0IDe-emphasis Enable pin in Pin Control modeHi-Z50DSDL1IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z51DSDR1IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z52TDM0ITDM Mode select 0 pin in Pin control mode. (@DSDPATH bit = "0")Hi-Z53DSDL2IDSD Clock pin in DSD mode (@DSDPATH bit ="0") (@DSDPATH bit = "0")Hi-Z54DSDL2IAudio Serial Data Input pin in Pin control mode. (@DSDPATH bit = "0")Hi-Z54DSDR2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z55I2CISerial Control Interface Select pin in Pin Control mode. (@DSDPATH bit = "0")Hi-Z55I2CISerial Control Interface Select pin in Register Control mode. "L": 3-wire serial control interface. "H": I?C Bus serial control interface.Pull-down to DVSS56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS	40	SSLOW		Digital Filter Select pin in Pin Control mode	11: 7
49TDMOOAudio Serial Data Output pin in Daisy Chain mode (Internal pull-down pin)DVSS (100 kΩ, typ)50DEM0IDe-emphasis Enable pin in Pin Control mode Audio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z51DSDR1IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z52TDM0ITDM Mode select 0 pin in Pin control mode. (@DSDPATH bit = "0")Hi-Z53DCLKIDSD Clock pin in DSD mode (@DSDPATH bit ="0") (@DSDPATH bit = "0")Hi-Z53DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z54DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z54DSDR2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z55INVRIDaisy Chain Mode Select pin in Pin Control mode. (@DSDPATH bit = "0")Hi-Z55I2CIR1/2ch Signal Invert pin in Pin Control mode (@DSDPATH bit = "0")Hi-Z56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS	48	WCK	I	Word Clock input pin in EXDF mode	HI-Z
50DSDL1IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z51DSDR1IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z52TDM0ITDM Mode select 0 pin in Pin control mode. (@DSDPATH bit = "0")Hi-Z52DCLKIDSD Clock pin in DSD mode (@DSDPATH bit ="0") (@DSDPATH bit = "0")Hi-Z53DCLKIDSD Clock pin in DSD mode (@DSDPATH bit ="0") (@DSDPATH bit = "0")Hi-Z53DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z54DCHAINIDaisy Chain Mode Select pin in Pin Control mode. (@DSDPATH bit = "0")Hi-Z54DCHAINIDaisy Chain Mode Select pin in DSD mode (@DSDPATH bit = "0")Hi-Z55INVRIR1/2ch Signal Invert pin in DSD mode (@DSDPATH bit = "0")Hi-Z55I2CISerial Control Interface Select pin in Register Control mode. "H": I <sup>2</sup> C Bus serial control interface. "H": I <sup>2</sup> C Bus serial control interface.Hi-Z56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS	49	TDMO	0		DVSS
DSDL1I(@DSDPATH bit = "0")51DSDR1IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z52TDM0ITDM Mode select 0 pin in Pin control mode. DCLKHi-Z52DCLKIDSD Clock pin in DSD mode (@DSDPATH bit ="0")Hi-Z53DSDL2IAudio Serial Data Input pin in Pin control mode. (@DSDPATH bit = "0")Hi-Z53DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z54DCHAINIDaisy Chain Mode Select pin in Pin Control mode. (@DSDPATH bit = "0")Hi-Z54DCHAINIDaisy Chain Mode Select pin in Pin Control mode. (@DSDPATH bit = "0")Hi-Z55INVRIR1/2ch Signal Invert pin in DSD mode (@DSDPATH bit = "0")Hi-Z55I2CISerial Control Interface Select pin in Register Control mode. "L": 3-wire serial control interface. "H": I²C Bus serial control interface.Hi-Z56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS		DEM0		De-emphasis Enable pin in Pin Control mode	
51DSDR11(@DSDPATH bit = "0")Hi-Z52TDM0ITDM Mode select 0 pin in Pin control mode. DCLKHi-Z53DCLKIDSD Clock pin in DSD mode (@DSDPATH bit ="0")Hi-Z53DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z54DCHAINIDaisy Chain Mode Select pin in Pin Control mode. (@DSDPATH bit = "0")Hi-Z54DSDR2IAudio Serial Data Input Pin in DSD mode (@DSDPATH bit = "0")Hi-Z54INVRIR1/2ch Signal Input Pin in DSD mode (@DSDPATH bit = "0")Hi-Z55I2CISerial Control Interface Select pin in Register Control mode. "H": I2C Bus serial control interface. "H": I2C Bus serial control interface. "H": I2C Bus serial control interface.Pull-down to DVSS56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS	50	DSDL1	I		Hi-Z
52DCLKIDSD Clock pin in DSD mode (@DSDPATH bit ="0")HI-Z53TDM1TDM Mode select 1 pin in Pin control mode.Audio Serial Data Input pin in DSD modeHi-Z53DSDL2IAudio Serial Data Input pin in DSD modeHi-Z54DCHAINIDaisy Chain Mode Select pin in Pin Control mode.Hi-Z54DSDR2IAudio Serial Data Input Pin in DSD modeHi-Z55INVRIR1/2ch Signal Invert pin in Pin Control mode.Hi-Z55I2CISerial Control Interface Select pin in Register Control mode.Hi-Z56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS	51	DSDR1	I		Hi-Z
DCLKIDSD Clock pin in DSD mode (@DSDPATH bit = 0 )1TDM1TDM Mode select 1 pin in Pin control mode.53DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")54DCHAINIDaisy Chain Mode Select pin in Pin Control mode.54DSDR2IAudio Serial Data Input Pin in DSD mode (@DSDPATH bit = "0")54IDSDR2I55INVRIR1/2ch Signal Invert pin in Pin Control mode. (@DSDPATH bit = "0")55I2CISerial Control Interface Select pin in Register Control mode. "H": 12C Bus serial control interface. "H": 12C Bus serial control interface.56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS	50	TDM0	Ι	TDM Mode select 0 pin in Pin control mode.	Li 7
53DSDL2IAudio Serial Data Input pin in DSD mode (@DSDPATH bit = "0")Hi-Z54DCHAINIDaisy Chain Mode Select pin in Pin Control mode. (@DSDPATH bit = "0")Hi-Z54DSDR2IAudio Serial Data Input Pin in DSD mode (@DSDPATH bit = "0")Hi-Z55INVRIR1/2ch Signal Invert pin in Pin Control mode. (@DSDPATH bit = "0")Hi-Z55I2CISerial Control Interface Select pin in Register Control mode. "L": 3-wire serial control interface. "H": I²C Bus serial control interface.Hi-Z56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS	52				I II-∠
DSDL2(@DSDPATH bit = "0")Hit = "0")54DCHAINIDaisy Chain Mode Select pin in Pin Control mode. (@DSDPATH bit = "0")Hi-Z54DSDR2IAudio Serial Data Input Pin in DSD mode (@DSDPATH bit = "0")Hi-Z55INVRIR1/2ch Signal Invert pin in Pin Control mode Serial Control Interface Select pin in Register Control mode. "L": 3-wire serial control interface.Hi-Z56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS		TDM1			
54DSDR2IAudio Serial Data Input Pin in DSD mode (@DSDPATH bit = "0")Hi-Z55INVRIR1/2ch Signal Invert pin in Pin Control modeHi-Z55I2CISerial Control Interface Select pin in Register Control mode. "L": 3-wire serial control interface. "H": I2C Bus serial control interface.Hi-Z56TESTIConnect to DVSS (Internal pull-down pin)Pull-down to DVSS	53	DSDL2			Hi-Z
DSDR2     I     (@DSDPATH bit = "0")       INVR     I     R1/2ch Signal Invert pin in Pin Control mode       55     I2C     I     Serial Control Interface Select pin in Register Control mode.       I2C     I     Serial Control Interface Select pin in Register Control mode.       "L": 3-wire serial control interface.     Hi-Z       56     TEST     I       Connect to DVSS (Internal pull-down pin)     Pull-down to DVSS		DCHAIN		Daisy Chain Mode Select pin in Pin Control mode.	
55     I2C     I     Serial Control Interface Select pin in Register Control mode.	54	DSDR2	I		Hi-Z
55     I2C     I     Serial Control Interface Select pin in Register Control mode.	55	INVR		R1/2ch Signal Invert pin in Pin Control mode	
56 TEST I Connect to DVSS (Internal pull-down pin) DVSS			1	Serial Control Interface Select pin in Register Control mode. "L": 3-wire serial control interface.	
	56	TEST	I	Connect to DVSS (Internal pull-down pin)	

No.	Pin Name	I/O	Function	Power Down State
57-60	VREFHR2	1	R2ch High Level Reference Voltage Input pin.	Hi-Z
61-64	VREFLR2	1	R2ch Low Level Reference Voltage Input pin.	Hi-Z
65-67	VSSR2	-	R2ch Analog Ground pin.	-
68-70	VDDR2	-	R2ch Analog Power Supply pin.	-
71	VCOMR2	Ι	R2ch VCOM pin. VCOMR2 is connected to the midpoint of resistors between VREFHR2 and VREFLR2.	Hi-Z
72	EXTCR2N	0	External Capacitor Connection pin. This pin should be connected to 1 $\mu F$ to VSSR2.	Pull-down to VSSR2 (250 kΩ, typ)
73,74	IOUTR2N	0	Current Output pin (R2ch negative signal).	Connected to OPINR2N (64 Ω, typ)
75	OPINR2N	0	Common Voltage Input pin (R2ch negative signal).	Connected to IOUTR2N (64 Ω, typ)
76	OPINR2P	0	Common Voltage Input pin (R2ch positive signal).	Connected to IOUTR2P (64 Ω, typ)
77,78	IOUTR2P	0	Current Output pin (R2ch positive signal).	Connected to OPINR2P (64 Ω, typ)
79	EXTCR2P	0	External Capacitor connection pin. This pin should be connected to 1 $\mu F$ to VSSR2.	Pull-down to VSSR2 (250 kΩ, typ)
80,81	NC	-	No internal bonding. Connect to AVSS.	-
82	EXTCL2P	0	External Capacitor connection pin. This pin should be connected to 1 $\mu$ F to VSSL2.	Pull-down to VSSL2 (250 kΩ, typ)
83,84	IOUTL2P	0	Current Output pin (L2ch positive signal).	Connected to OPINL2P (64 Ω, typ)
85	OPINL2P	0	Common Voltage Input pin (L2ch positive signal).	Connected to IOUTL2P (64 Ω, typ)
86	OPINL2N	0	Common Voltage Input pin (L2ch negative signal).	Connected to IOUTL2N (64 Ω, typ)
87,88	IOUTL2N	0	Current Output pin (L2ch negative signal).	Connected to OPINL2N (64 Ω, typ)
89	EXTCL2N	0	External Capacitor connection pin. This pin should be connected to 1 $\mu F$ to VSSL2.	Pull-down to VSSL2 (250 kΩ, typ)
90	VCOML2	I	L2ch VCOM pin. VCOML2 is connected to the midpoint of resistors between VREFHL2 and VREFLL2.	Hi-Z
91-93	VDDL2	-	L2ch Analog Power Supply pin.	-
94-96	VSSL2	-	L2ch Analog Ground pin.	-
97-100	VREFLL2	I	L2ch Low Level Reference Voltage Input pin.	Hi-Z
101-104	VREFHL2	I	L2ch High Level Reference Voltage Input pin.	Hi-Z
105	EXTR	I	External Resistor connection pin. This pin should be connected to 33 k $\Omega$ (±1 %) to AVSS.	Hi-Z
106	AVSS	-	Analog Ground pin	-
107	AVDD	-	Clock Interface Power Supply Pin, 4.75 ~ 5.25 V	-

No.	Pin Name	I/O	Function	Power Down State
108	MCLK		Master Clock Input pin	Hi-Z
109	DVDD	0	(LDOE pin = "H") LDO Output pin. This pin should be connected to DVSS with 1.0 $\mu$ F. This pin is prohibited to connect to other devices.	DVSS
		-	(LDOE pin = "L") 1.8 V Digital Power Supply pin	-
110	DVSS	-	Digital Ground pin	-
111	TVDD	-	Digital Power Supply pin, 3.0 V~3.6 V	-
112	LDOE	Ι	Internal LDO Enable pin. "L": Disable, "H": Enable	Hi-Z
113	PDN	I	Power-Up, Power-Down pin When at "L", the AK4499 is in Power-Down mode. The AK4499 must always be in Power-Down mode upon supply power on.	Hi-Z (PDN = "L")
114	SMUTE	I	When this pin is changed to "H", Soft Mute cycle is initiated. When returning to "L", Soft Mute releases.	Hi-Z
	CSN	Ι	Chip Select pin in 3-wire serial Register Control mode	
	SD	Ι	Digital Filter Select pin in Pin Control mode	
115	CCLK	Ι	Control Data Clock pin in 3-wire serial Register Control mode	Hi-Z
	SCL	I	Control Data Clock Input pin in I <sup>2</sup> C Bus Register Control mode	
	SLOW		Digital Filter Select pin in Pin Control mode	
116	CDTI	Ι	Control Data Input pin in 3-wire serial Register Control mode	Hi-Z
	SDA	I/O	Control Data Input pin in I <sup>2</sup> C Bus Register Control mode	
	DIF0		Digital Input Format 0 pin in Pin Control mode	Pull-down to
117	DZFL	0	Lch Zero Input Detect pin in Register Control mode (Internal pull-down pin)	DVSS (100 kΩ, typ)
	DIF1		Digital Input Format 1 pin in Pin Control mode	Pull-down to
118	DZFR	0	Rch Zero Input Detect pin in Register Control mode (Internal pull-down pin)	DVSS (100 kΩ, typ)
110	DIF2	Ι	Digital Input Format 2 pin in Pin Control mode	
119	CAD0	I	Chip Address 0 pin in Register Control mode	Hi-Z
120	VTSEL	I	MCLK VIH/L Level Select pin. VTSEL = "L"; VIH = 1.36 V, VIL = 0.34 V VTSEL = "H"; VIH = 2.2 V, VIL = 0.8 V	Hi-Z
121-124	VREFHL1	Ι	L1ch High Level Reference Voltage Input pin.	Hi-Z
125-128	VREFLL1		L1ch Low Level Reference Voltage Input pin.	Hi-Z
-	TAB	-	The TAB on the bottom surface of the package should be connected to AVSS.	-

Note 2. All input pins except internal pull-up/down pins must not be left floating.

Note 3. The AK4499 must be powered down by the PDN pin when changing Pin Control/Register Control modes by the PSN pin.

Note 4. PCM mode, DSD mode, and EXDF mode are selectable in Register Control mode.

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